## SECTION 46

## SCOUR AT BRIDGES

### 1.46.1 DEFINITIONS

Scour, General or Contraction - Scour in a channel or in a flood plain that is not localized at a pier or other obstruction to the flow. In a channel, general/contraction scour usually affects all or most of the channel width and is typically caused by contraction of the flow.

Scour, Local - Scour in a channel or in a flood plain that is localized at a pier, abutment or other obstruction to the flow.

Thalweg - A line extending down the length of a channel that follows the lowest elevation of the bed.

Refer to FHWA Hydraulic Engineering Circular (HEC) No. 20 entitled Stream Stability at Highway Structures, for additional definitions regarding stream geomorphology and scour.

### 1.46.2 GENERAL

a. All bridges located over a waterway, shall be designed to resist scour, through methods outlined in FHWA HEC No. 18 entitled Evaluating Scour at Bridges, and FHWA HEC No. 20 entitled Stream Stability at Highway Structures.

b. All bridge foundations shall be designed to withstand the effects of scour from a 100 year flood criteria, or less, that is expected to produce the most severe condition. A factor of safety of 2 to 3 shall be used to account for the effects of this flood.

The foundation design shall be checked for a 500 year superflood, or 1.7 times a 100 year flood, if a 500 year superflood information is not available from published sources, and modifications made where required. All foundations should have a minimum factor of safety of 1.0 under the superflood conditions.

When evaluating existing bridges, the superflood criteria shall be the 100 year discharge, or less, that is expected to produce the most severe condition. However, in some cases a flood discharge greater than the 100 year flood criteria may be necessary. These cases will be evaluated on a bridge by bridge basis.

c. If required, the Preliminary submission shall include a Hydraulic and Scour Report which should establish a design procedure for scour resistance. The following structural elemental information should be addressed in this Report.

**SUPERSTRUCTURE**

1.) Whenever practical, the elevation of the bridge superstructure should be above the general elevation of the approach roadways.

2.) For streams that carry a large amount of debris, the elevation of the lower cord of the bridge should be increased a minimum of 600 millimeters above the normal freeboard for a 100 year flood.

**ABUTMENTS**

1.) Rock riprap, guide banks (spur dikes) and other scour countermeasures as outlined in Chapter 7 of HEC No. 18 shall be considered for use on a project to project basis on bridge rehabilitation projects as determined by a bridge scour evaluation.

2.) The design of abutments should consider that the channel may shift and scour may occur at the abutment.

**PIERS**

1.) The number of piers in any stream channel should be limited to a practical minimum, and piers should not be located in the channel of small streams, if it is possible to avoid such locations.

2.) Piers shall be aligned with flow direction at flood stage in order to reduce drift build up, reduce the contraction effect of piers in the waterway, minimize ice forces and the possibility of ice dams forming at the bridge and to minimize backwater and local scour. The top of footing shall be a minimum of 900 millimeters below the waterway bed.

3.) Piers subject to tidal conditions shall be protected on all sides by granite masonry facing or a stainless steel protection plate. The limits shall extend 600 to 900 millimeters above the mean high water line to 600 to 900 millimeters below the mean low water line. Refer to Guide Sheet Plates 3.5-5 and 3.5-6 for more information concerning granite masonry protection of pier faces.

4.) If there is a likelihood that the channel will shift its location in the flood plain during the expected 75 - 100 year life of the bridge, pier foundations in flood plains should be designed to the same elevation as the pier foundations in the stream channel.

5.) Evaluate the hazard of ice and debris buildup, particular for multiple pile bents. Evaluate a bent pier as though it is a soild pier for scour estimation. Consider the use of other pier types.

**FOUNDATIONS**

1.) The bridge foundation analysis shall be performed on the basis that all stream bed material in the 100 year scour prism above the total scour

line has been removed and is not available for bearing or lateral support.

2.) When designing pile foundations, the piles shall be designed for additional lateral restraint and column action requirements due to the increase in unsupported pile length after scour occurs. Additional lateral loads due to stream pressure should be included in the pile design. Consideration should be given to using a lesser number of longer piles as compared with a greater number of shorter piles to develop bearing loads. This approach will provide a greater factor of safety against pile failure due to scour at little or no increase in cost.

3.) For spread footings on soil, ensure that the top of the footing is at or below long term degradation, contraction scour and lateral migration considerations. Place the bottom of the footing below the total scour line.

4.) For spread footings on highly resistant rock, place the bottom of the footing on a cleaned rock surface (consider doweling for lateral restraint).

5.) For spread footings on erodible rock, consult an Engineering geologist for the rock quality and local geology. Estimate the potential scour depth and place the footing base below that depth. Place the final footing in contact with the sides of excavation and fill the excavation above the footing with riprap.

6.) For spread footings on tremie seals and soil, place the bottom of the footing below the total scour line and ensure that the top of footing is at or below the sum of long term degradation and contraction scour. This will minimize obstruction during flood flow and resulting local scour.

7.) For deep foundations (drilled shafts or driven piles) with footings or caps, place the top of the footing below the stream bed a depth that is equal to the estimated long term degradation and contraction scour to minimize obstruction during flood flow and resulting local scour.

8.) Local scour holes at piers and abutments should not overlap (top width of a scour hole can be as much as 2.8 times the depth of scour).